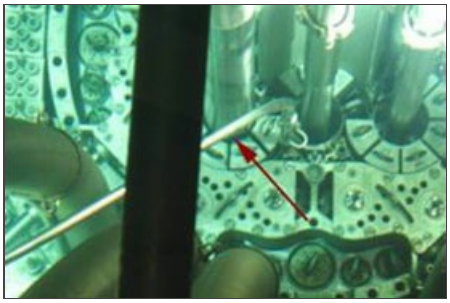
University of Illinois fellow Carolyn Tomchik loads Transmission Electron Microscopy (TEM) disks into capsules to be irradiated in the Advanced Test Reactor using the shuttle.

First ATR National Scientific User Facility Experiment Successfully Uses Hydraulic Shuttle

By Julie Ulrich *for Communications and Governmental Affairs*

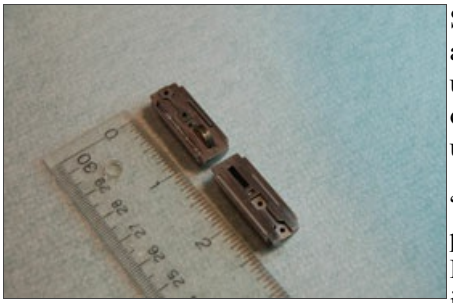
A new shuttle system is changing the way experiment specimens are handled at Idaho National Laboratory's Advanced Test Reactor (ATR). The newly installed hydraulic shuttle irradiation system (HSIS) was successfully used for the first time for an ATR National Scientific User Facility (NSUF) irradiation experiment for University of Illinois researchers.



A red arrow points to the Hydraulic Shuttle Irradiation System Transport Tube in the Advanced Test Reactor vessel.

The hydraulic shuttle system (or "rabbit") adds another capability to ATR and allows for flexible irradiation test periods. The ATR can be used to perform several different types of irradiation experiments simultaneously, at different power, temperature, and pressure levels, depending on the placement of the individual experiment, and how long it is in the reactor core. The shuttle dramatically improves the range of duration of possible experiments. The new hydraulic shuttle irradiation system was made possible through a joint effort between INL, the state of Idaho and Idaho State University (ISU). In 2006, then Idaho Governor James Risch authorized a partial loan to Battelle Energy Alliance, the contractor that operators INL, to install the shuttle system. Since then, researchers at INL and ISU have been preparing the HSIS equipment and systems for use by organizing experiments, establishing safety measures and performing operational documentation reviews.

The shuttle operates like a bank's drive-up pneumatic canister transport system, but instead of using air, 14 capsules are transferred in and out of the reactor core through 100-foot-long stainless steel transfer tubes with flowing water. The capsules, each the size of a roll of pennies, are transported inside the ATR shuttle tubing. Prior to the shuttle installation, experiment test trains and samples could only be inserted or removed manually when the reactor was not operating, during one to two week outages.



The inside of a loaded shuttle.

Specimens would have to remain in the reactor during the entire operating cycle which could last for a few months. Now sample irradiation periods can be tailored by using the new HSIS to match users' needs, meet experiment specifications, and do not have to align with ATR operating and outage schedules. This flexibility opens up new research opportunities at ATR for DOE research, university experiments, and industry participants, allowing for experiments as short as minutes.

"One of the biggest advantages of the hydraulic shuttle is that it allows for very short irradiation periods. Researchers are able to analyze defects in materials at the very start of the problem," said Dan Ogden, ATR NSUF Irradiation Experiment project manager. Researchers can compare un-irradiated materials properties with irradiated test specimens in order to understand neutron damage effects and model them as a function of time, neutron energy, temperature, etc. The use of the shuttle allows for versatile experiment configurations.

"The system transports 14 individual shuttle capsules into the reactor each time it is used," explained Joe Palmer, INL's lead engineer for the Illinois experiment. "Each shuttle capsule can be from a different sponsor, so it is possible to conduct 14 unique experiments simultaneously. The shortest turnaround would be about 10 minutes. The longest could be several full ATR cycles – possibly six months or more."

The initial demonstration of the new HSIS featured a six-capsule University of Illinois experiment that is part of their ATR NSUF project grant entitled "Irradiation Performance of Fe-Cr Base Alloys". The Illinois experiment will shed light on the processes that occur in both standard and developmental steel alloys when they are irradiated by neutrons inside reactors. The ATR test results will provide irradiation performance data that be used as benchmark information and to determine which improved steel alloys can be used in new advanced reactors by analyzing the

changes in the material strength, resilience and properties after neutron bombardment.

A completed shuttle is weighed prior to insertion into the reactor.

The Illinois experiment was irradiated in the ATR for ten days, and used six (6) capsules containing steel alloy specimens, with eight (8) empty capsules, to provide spacing between the loaded capsules. A second University of Illinois experiment capsule was inserted for a one-day irradiation. Future ATR NSUF experiments will use the HSIS "rabbit" system, including a 10-day irradiation for Drexel University followed by a University of Central Florida experiment during the summer of 2012.

The ATR NSUF, one of 40 Department of Energy's national scientific user facilities in the U.S., grants universities access to world-class research reactor and hot cell facilities at no cost in order to advance nuclear and science technology. ATR NSUF projects are funded by the DOE Office of Nuclear Energy after a competitive independent peer reviewed proposal selection process. To date, 34 project proposals have been awarded by the ATR NSUF since its inception in 2008. For more information about submitting proposals, user information and guideline documents, visit the ATR NSUF website at http://atrnsuf.inl.gov

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